Space Weather Technical Forecast

Issued on Sunday, 18 September 2022 at 13:26 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Slight chance G1 overnight day 1 and into day 2 (18th/19th). Ongoing chance of M-flares/R1-R2 Radio Blackout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was Moderate over the past 24 hours, with two M-class flares recorded at GOES16 from AR3098 from over the northwestern limb: M1.9 at 17/1339UTC and M2.6 at 17/2041UTC. There are five sunspot regions on the visible disc. The most notable is AR3102 Eai/Beta which has seen redevelopment amongst its trailer region, although it remains a magnetically simple region, now approaching the southern centre disc. There are two other numbered regions in the southwest, AR3100 Dso/Beta and AR3103 Bxo/Beta both of which are simple and decaying, and two newly emergent but unnumbered regions also in the southwest. No Earth-directed CMEs were observed in the last 24 hours

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR and ACE at L1, increased from initially background levels of near 350km/s to be slightly elevated at around 430-470km/s likely due to the arrival of the fast wind of CH23/-. This increase, from around 18/0900UTC followed a decrease in density from slightly above average, peaking 15 ppcc at DSCOVR, to below average levels. The total interplanetary magnetic field (IMF), Bt has been Moderate throughout at 8-12nT with the north-south component Bz, ranging between -10nT and +10nT. While brief periods of negative (southward) field were observed, Bz was more predominately positive (northward). The phi angle remained negative (towards the Sun). Geomagnetic activity was Quiet to Unsettled (Kp 0-3).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16, remained slightly elevated above background levels over the 24 hours, but less than 2.5pfu. High energy electron flux (greater than 2 MeV) was generally at background to Moderate, with the associated 24 hour fluence remaining well below the Active (1e8 integrated pfu) threshold. Observed fluence at 18/0000UTC was 5.93e6 integrated pfu).

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to ease to Low, but with a chance of rising again to Moderate with any notable flaring of AR3102. Flare risk may also increase as ex-3098 rotates onto the disc.

Solar Wind / Geomagnetic Activity: A CME, accounting for the combination of two filament eruptions starting 15/2100UTC and 16/0100UTC from the southwest quadrant, may glance Earth later on the 18th or early 19th. However confidence is low for the timing of any arrival, with the bulk of the CME material also expected to miss, passing ahead of the Earth. The arrival of the fast wind of CH23 is expected to continue increasing wind speeds through day 1 (18th), peaking later or early day 2 (19th) at around 500 km/s, before easing again towards background. No further enhancements expected. Geomagnetic activity will be Quiet to Unsettled at first, with isolated Active intervals possible. There is a slight chance of G1 Minor Storms either later day 1 (18th) or early day 2 (19th) depending on any CME arrival. Activity then easing to be mostly Quiet day 3 onward.

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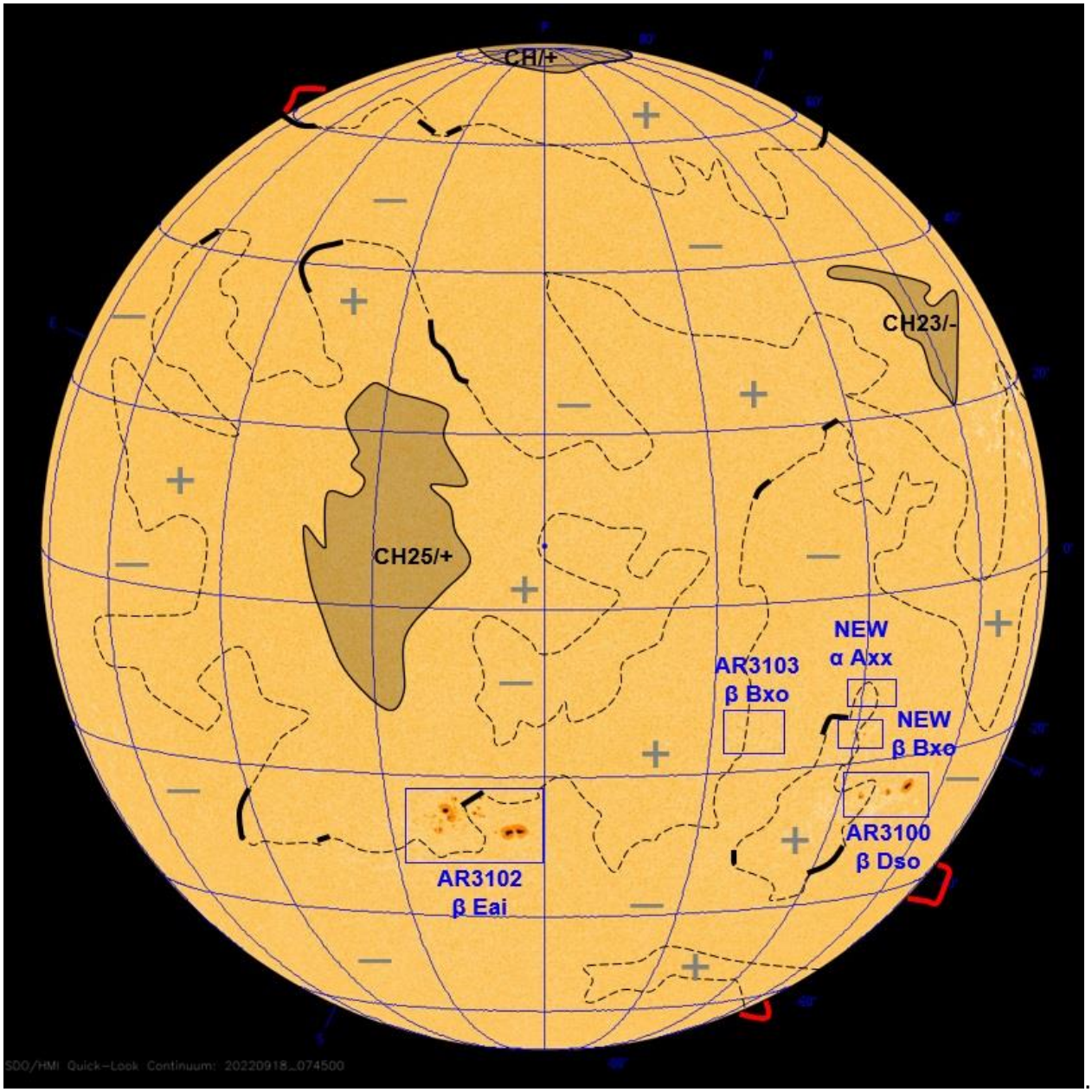
Energetic Particles / Solar Radiation: Current very slightly elevated high energy (greater than 10 MeV) proton flux observed by GOES-16 is expected to gradually ease through the period. There is only a very slight chance of this rising above the S1 level (10pfu), with any notable flaring that may occur from AR3102. The high energy electron flux (greater than 2MeV) is expected to be at mainly Background at first, but rising day 2 onward due to recent fast wind and possible CME enhancement, perhaps reaching High at diurnal peak. This will give a slight chance of the 24-hr fluence rising to be Active (1e8 integrated pfu) by the end of the period, but most likely remaining below the Active threshold.

Figure 1. Solar Analysis Valid 18/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There is one CME that is expected to pass by Earth, perhaps giving a glancing interaction late on day 1 (18th) or 2 (19th). This is the product of two filament eruptions starting 15/2100UTC and 16/0100UTC from the southwest quadrant. The arrival timing and strength is low confidence due to the background enlil solar winds being notably different to those currently observed, coupled with only a glancing interaction being indicated.

Earth is currently moving into the fast wind of negative polarity CH23, with solar winds recently slightly enhanced. This is unfavoured for a significant geomagnetic connection, but may prime conditions ahead of any subsequent CME arrival, should it occur. Peak winds are likely early day 2 (19th), before easing gradually thereafter, likely returning to background day 3 (20th). No further notable enhancements are indicated.

Geomagnetic activity will be Quiet to Unsettled at first, with isolated Active intervals possible. There is a slight chance of G1 Minor Storms either later day 1 (18th) or early day 2 (19th) depending on any CME arrival. Activity then easing to be mostly Quiet day 3 onward.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	20	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
16/0703 UTC	Partial	2 Filament Eruptions	SW	636 km/s	18/2100 UTC	Glancing impact. Low confidence on timing and strength.

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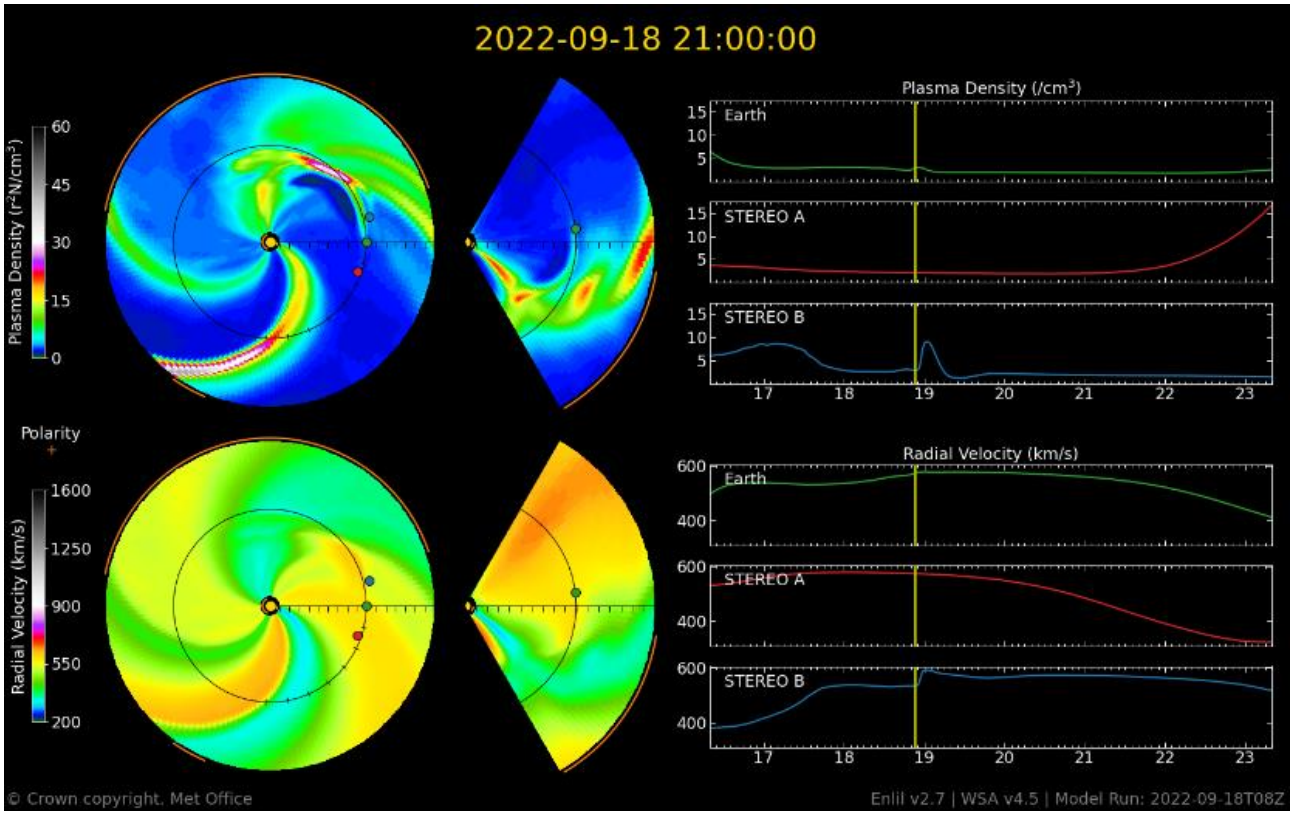
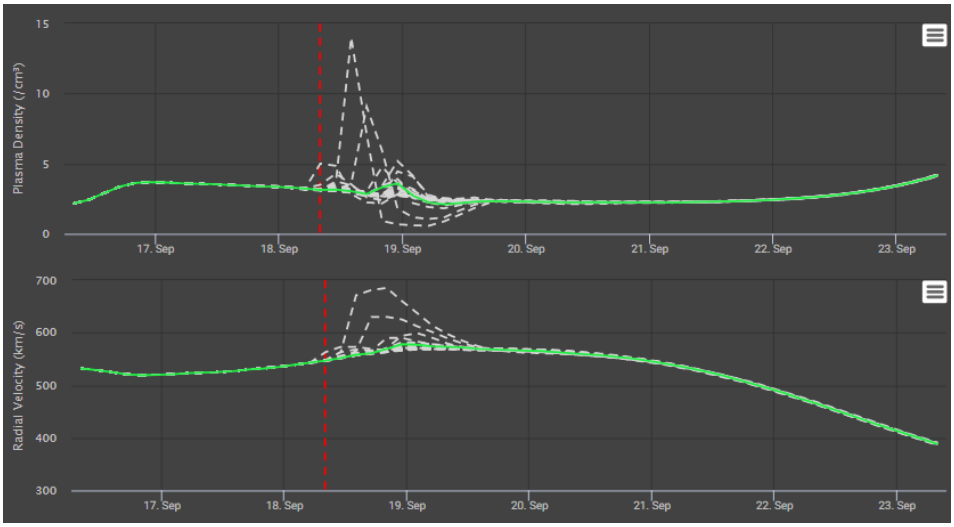
Figure 2: Enlil and ensemble





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Radio Blackouts - X-Ray Flares:

Solar Activity is currently Moderate with two M-flares observed in the last 24 hours, both from AR3098 from beyond the west limb. This region has continued to rotate away, with any subsequent flaring increasingly unlikely to have a notable impact on the X-ray flux observed at Earth. Consequently, activity is expected to become Low, with a chance of rising to Moderate due to any further M-flares.

There are five active regions on the disc, three numbered and two small unnumbered emergent areas that have developed simple spots in the southeast. AR3102 Eai/Beta is the most interesting, showing development around its trailer with a proliferation of small spots. This is despite a recent trend of weakening, after transitioning across the far-side with some notable activity observed. Despite this, it has remained stable with a relatively simple magnetic structure, although this does have the potential M-class flares. AR3100 Dso/Beta is a smaller, and declining region in the southwest, whilst AR3103 Bxo/Beta is a very small decaying region also in the southwest.

There is also ex-AR3089 which is approaching the southeast limb on the far-side. The looping of this region is visible on SDO imagery, along with a bright region on STEREO euvi. This is expected to rotate on the Earth-facing disc during day 2 (19th), and may increase the flare risk further in the coming days.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	30	30	30	30
Very Active	R3 to R5 X Class	No	2	2	2	2

Figure 3: GOES-16/17 X-ray Flux

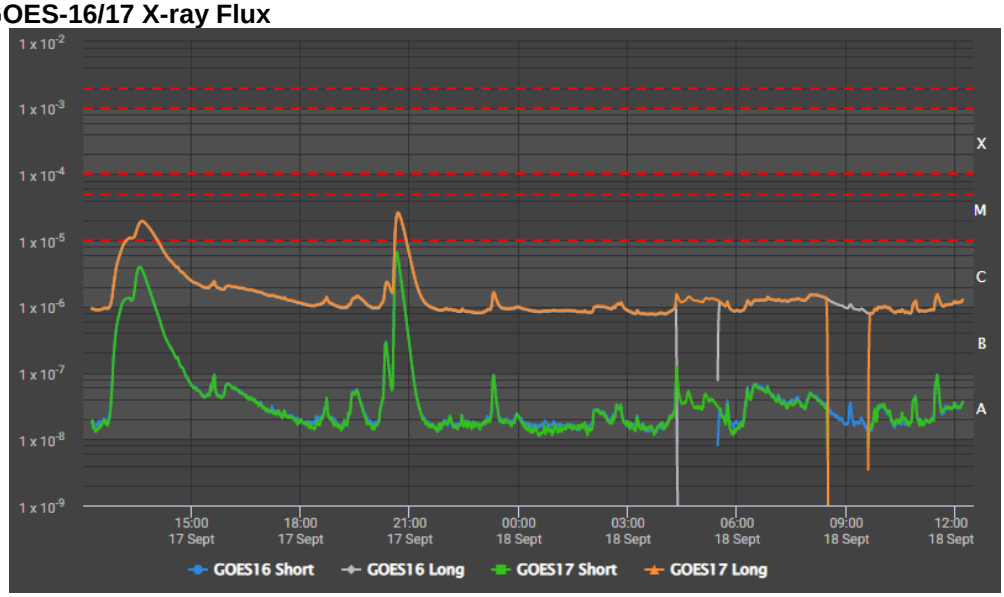

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Figure 3b: SDO hmi intensitygram and Magnetogram of AR3102 Eai/Beta

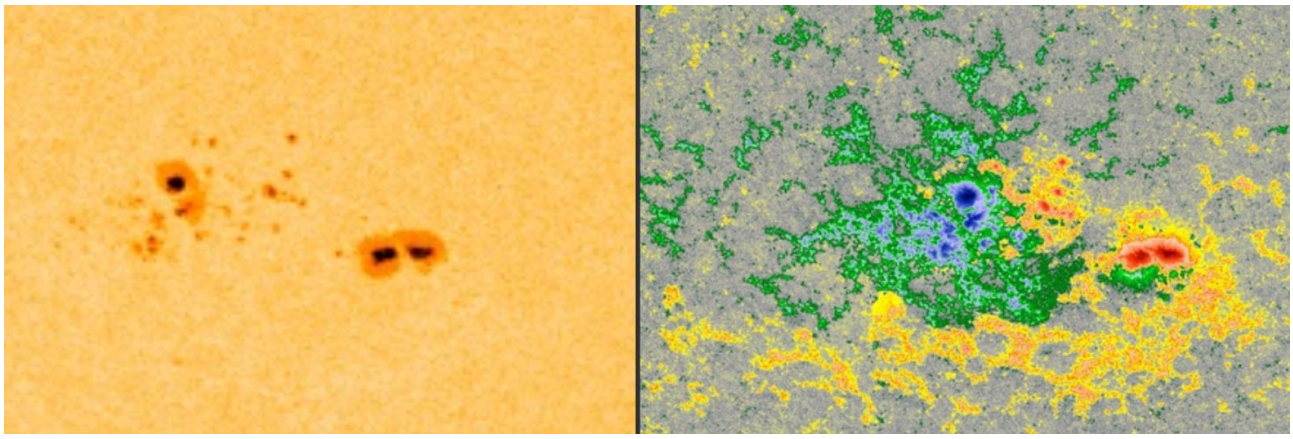
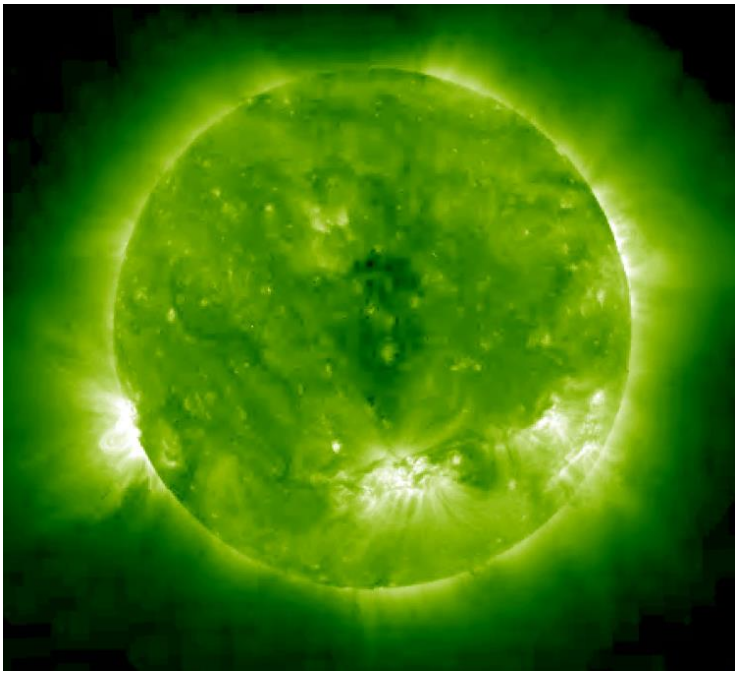
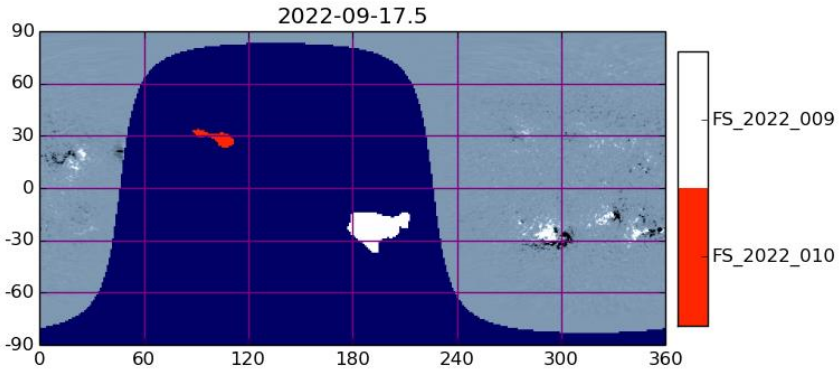


Figure 3c: STEREO A euvi and Far-side helioseismograph (from jsoc.stanford.edu) showing ex-3098 (far southeast on STEREO A)





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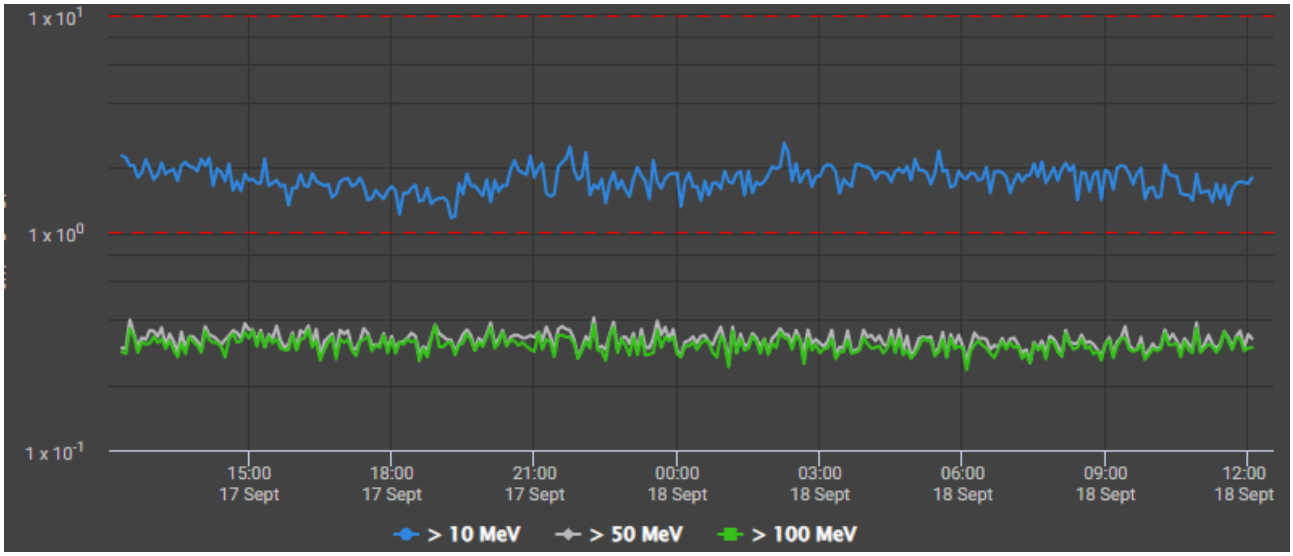
Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10MeV) observed by GOES-16 remains slightly elevated at above background levels, but below the S1 level. These conditions have persisted for a number of days, with only a gradual decline towards background expected.

AR3098, which has been the source of recent flaring has not resulted in any further notable increased in the observable proton flux at Earth, and has now rotated well beyond the west limb. Whilst it isn't impossible that notable flaring from this region could still result in increased proton flux at Earth, the most likely source of any subsequent enhancement would be from any activity from AR3102 which is now approaching the central southern disc. This giving a very slight chance of reaching the S1 level.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	3	3	3	3
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: GOES-16 >10MeV, >50MeV and >100 MeV proton flux



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High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2 MeV) as observed by GOES-16, is currently at Background to Moderate levels. The arrival of the fast wind of CH23, alongside any CME influence, is likely to keep flux levels subdued on day 1 (18th) before a gradual rise is expected day 2 and potentially day 3 (19th/20th). This may result in flux reaching High at diurnal maximum, but due to the relatively limited connection expected to CH23 alongside only glancing CME interaction, persistently high flux is only a low risk

The associated 24 hr fluence is expected to remain below the Active threshold, albeit with a rising trend in response to any elevated flux. REFM has yet to show any forecast increasing trend due to recent solar wind enhancement, and whilst 27-day recurrence is currently running above the Active threshold, this was due to a much stronger fast wind connection on the last rotation.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	5	20	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: GOES 16 >2 MeV Electron flux and Fluence with REFM and 27-day recurrence forecasts.

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